Monitoring Networks and Adaptive Resource Management

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National Park Service

April 21, 2010

Las Vegas, NV

32 NPS Inventory and Monitoring Networks

More than 270 park units with significant natural resources are organized into 32 ecoregional networks that share core funding and a professional staff to conduct long-term monitoring of park ecosystems.

Vital Sings Monitoring and Adaptive Resource Management

“Vital Signs” are a relatively small set of information-rich attributes that are used to track the condition and trend in the overall “health” of park natural resources and to provide early warning of situations that may require management intervention.

Benefits

Share scientific expertise and technical skills

Maximize efficiency in protocol development and implementation

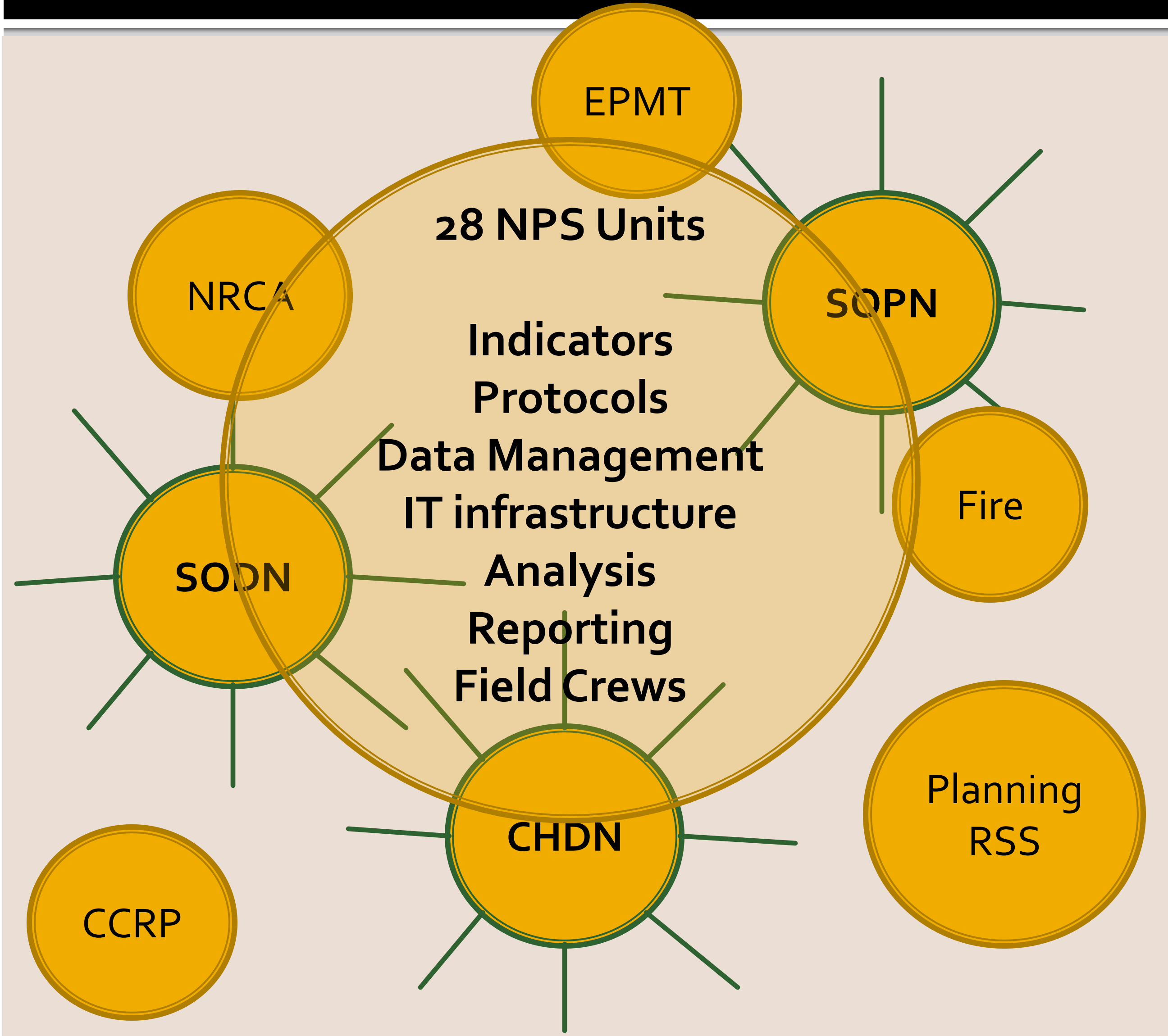
Maximize efficiency of data management and systems admin

Share contract admin to save time and money

Increase efficiency in analysis and reporting

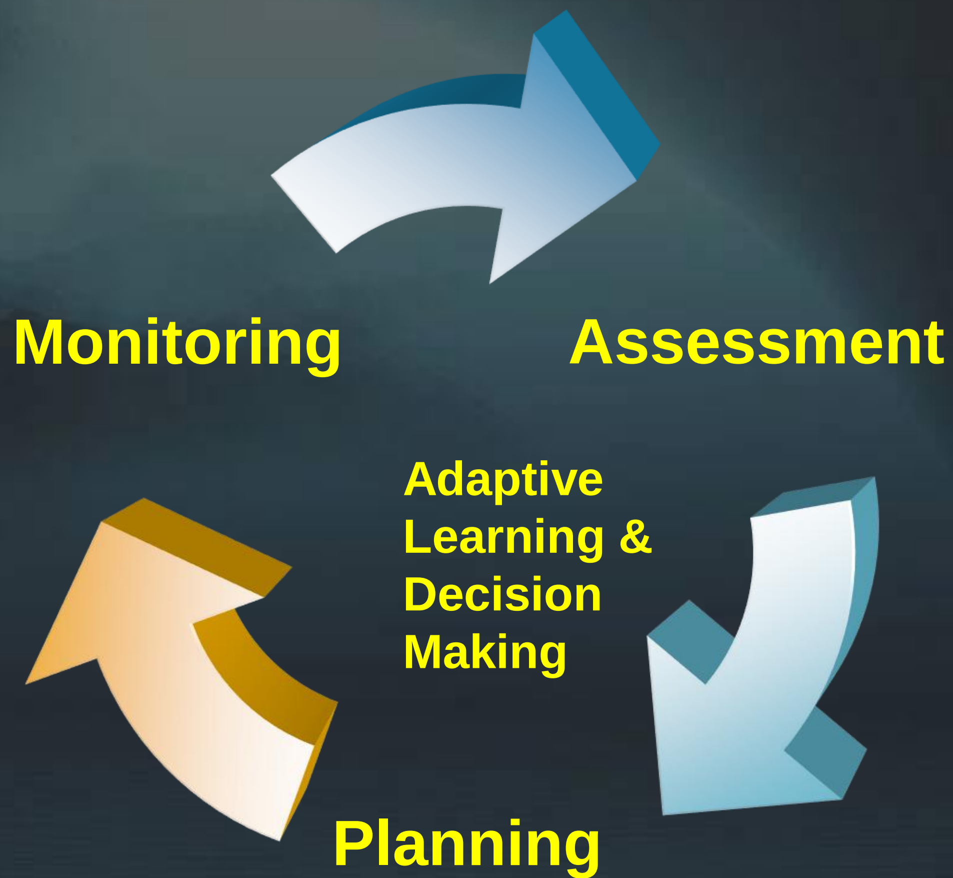
Report results at broader ecoregional scales

Network of Networks

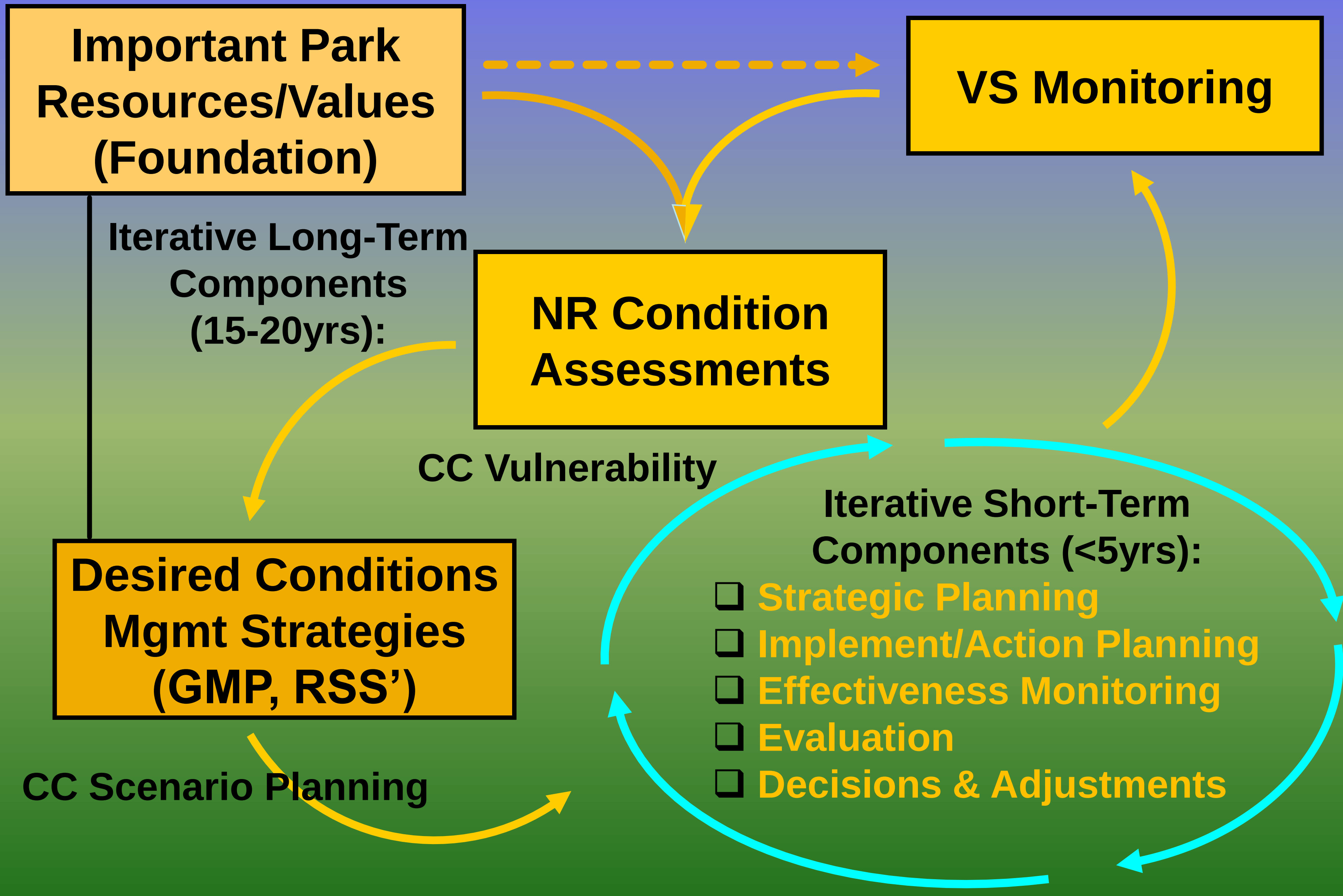


Inventory and Monitoring Goal

"Integrate natural resource inventory and monitoring information into National Park Service planning, management, and decision making."



Connecting Planning, Monitoring and Assessment



Challenges

- Long-term resource planning, monitoring, and assessment should be more resource centric in space and time, versus focus on admin boundaries and current 20 year plan life-cycles
- Long-term broad-scale strategies should be coordinated across multiple park units, and across other land management agencies
- Example: Northwest Forest Plan

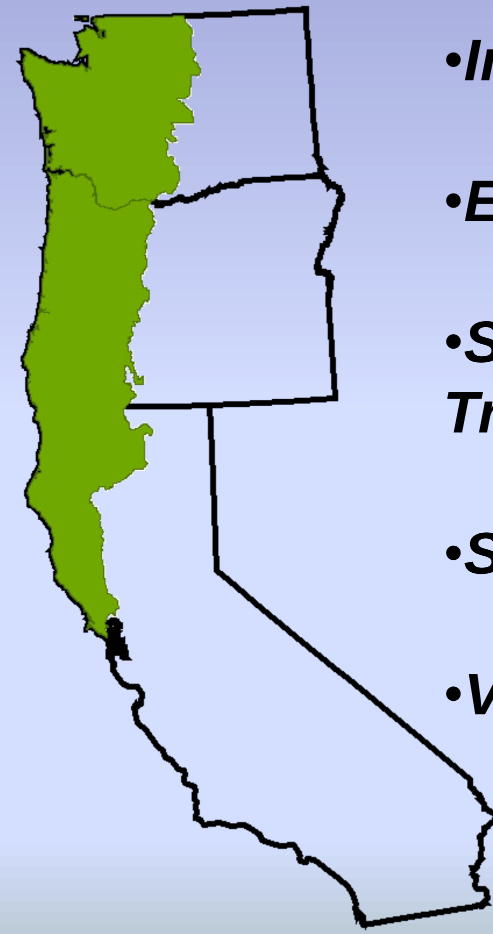
The Right Scale

Northwest Forest Plan

Resource Planning Goal:

Sustain the amount and distribution of late-seral old-growth forest and related species throughout the range of the northern spotted owl for 100 years

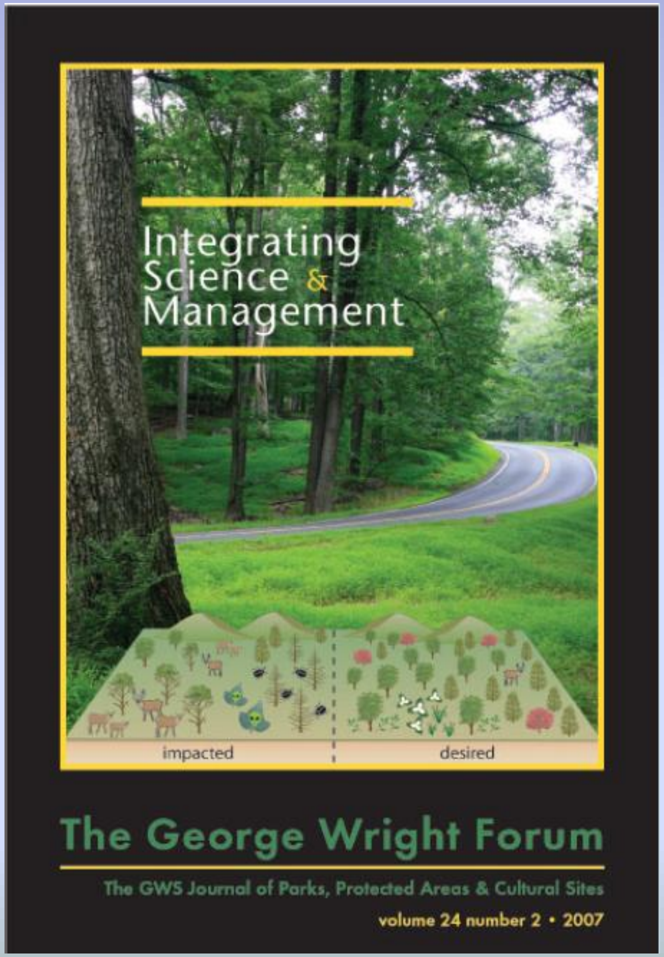
USFS, BLM, USFWS, NPS, BOR, States and others



- ***Implementation***
- ***Effectiveness***
- ***Status and Trend***
- ***Socio-Economic***
- ***Validation***
  - ***Assumptions***
  - ***AMAs***

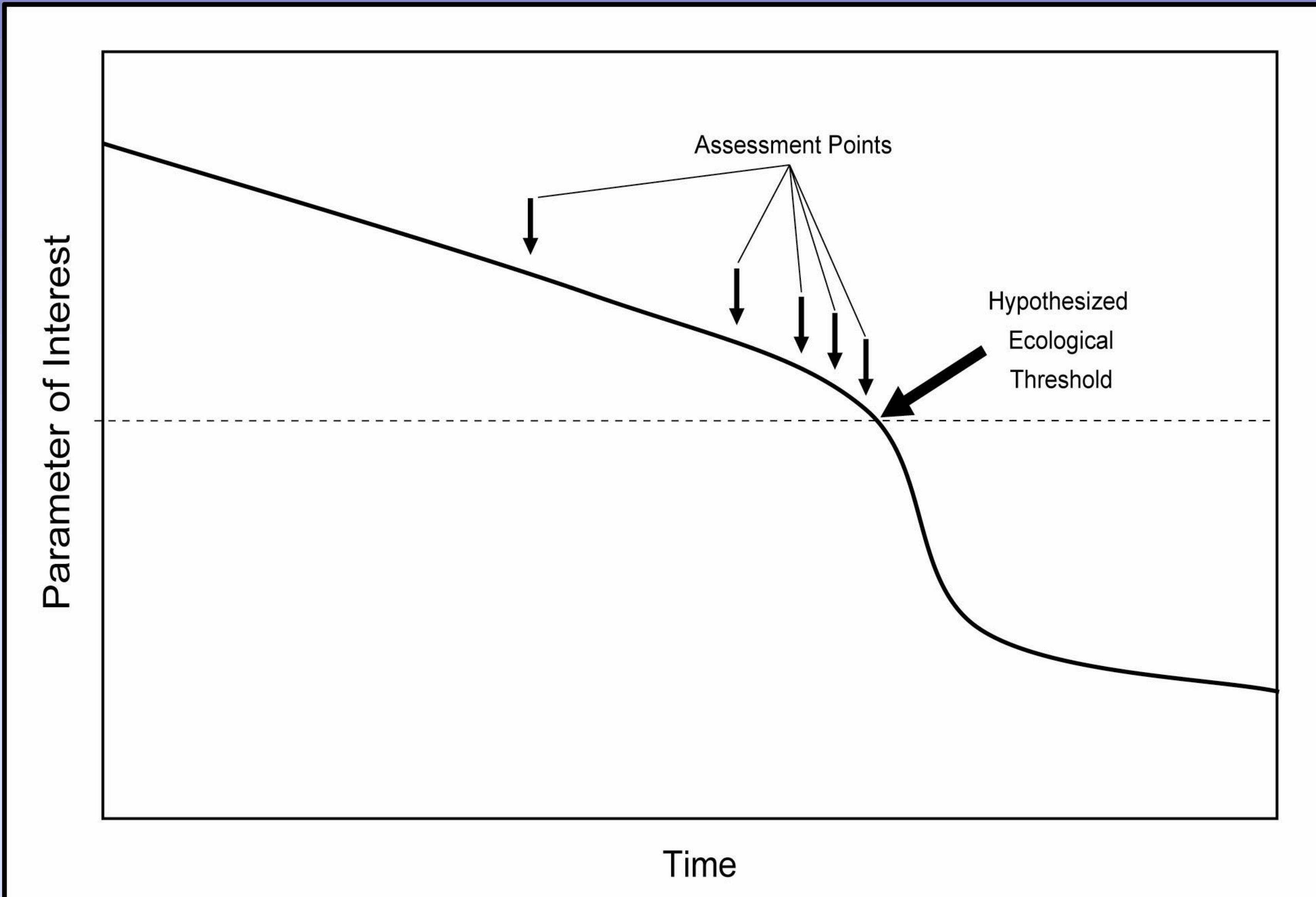
Integrating Science and Management

- Basic inventory and monitoring data
- Management thresholds – assessment points
- Structured decision making and risk analysis
- USGS/NPS studies – Integrated analysis
- Predictive models
- Decision support tools – EMDS



Set Management Thresholds or Assessment Points

Approach for alerting managers to potential ecological thresholds, using a generalized approach for determining when an assessment of the resource condition and possible management responses (including no action) might be considered.



Assessment points can be assigned before a hypothesized ecological threshold is reached in order to account for the uncertainty of the actual value of that threshold or to assess the risk of the current trajectory ***(Robert E. Bennetts et al. 2007. Linking Monitoring to Management and Planning: Assessment Points as a Generalized Approach. The George Wright Forum, 27:2, 59-77.).***

Management Assessment Points in Action

Table 2.2.4. Proposed management assessment points for terrestrial vegetation and soils parameters monitored at Fort Bowie National Historic Site.

Issue	Management assessment point*	Information source
Erosion hazard	1 Bare ground cover is >30%	La Cienegas National Conservation Area Management Plan (2003, as cited in Gori and Schussman 2005)
	2 Percentage of surface soil aggregates in "very stable" (6) class is <20%	Value is based on professional judgment of authors; issue is described in Herrick et al. 2005b
Site stability	3 Foliar cover of perennial grasses in field layer is <25%	Value is based on professional judgment of authors; issue is described in Herrick et al. 2005a
	4 Proportion of foliar grass cover (%) of annuals in field layer is >33%	Value is based on professional judgment of authors; issue described in Laycock 1991, Corbin and D'Antonio 2004
Shrub encroachment	5 Shrub foliar cover in field and/or subcanopy layer(s) is >35%	McAullife 1995; McPherson 1997; Pellant et al. 2000
Mesquite invasion	6 Mesquite (*Prosopis* spp.) foliar cover in subcanopy and/or canopy layer(s) is >20%	
Exotic plant dispersal	7 Extent (plot frequency) of invasive exotic plants in any layer is >20%	Professional judgment of authors; see SODN Monitoring Plan (NPS 2005) for an overview of the issue
Exotic plant invasion	8 Proportion of foliar plant cover (%) contributed from exotic plants in field layer (etc.) is >10%	

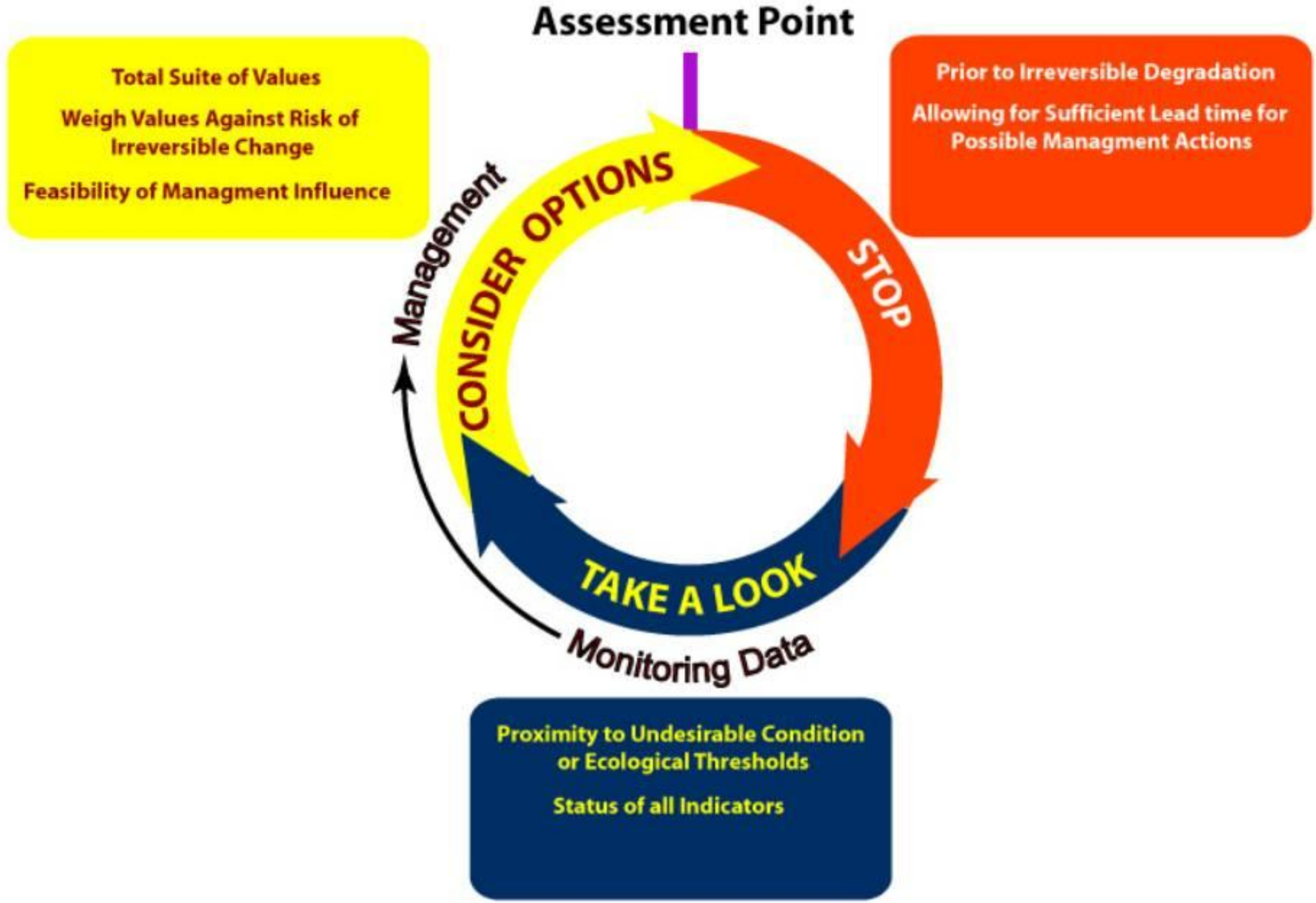
*If current status measurements fall within the levels indicated, then additional review and consideration of the resource issue is needed.

Assessment Points Provide Context…

Table 3.3. Terrestrial vegetation and soils monitoring data in the context of proposed management assessment points, Fort Bowie NHS, 2008.

Issue	Management assessment point*		Parkwide mean	SE	MDC	n=	Point met?	Recommendation
Erosion hazard	1	Bare ground cover is >30%	0.39%	0.08%	5%	1	No	Continue monitoring
	2	Percentage of surface soil aggregates in "very stable" (6) class is <20%	36%	4.16%	10%	10	No	Continue monitoring
Site stability	3	Foliar cover of perennial grasses in field layer is <25%	39%	2.47%	10%	4	No	Continue monitoring
	4	Proportion of foliar grass cover (%) of annuals in field layer is >33%	36%	4.17%	10%	10	YES	Meet and consider
Shrub encroachment	5	Shrub foliar cover is >35% (field)	2.6%	0.88%	5%	2	No	Continue monitoring
	5	Shrub foliar cover is >35% (subcanopy)	3.6%	1.43%	5%	5	No	Continue monitoring
Mesquite invasion	6	Mesquite (*Prosopis* sp.) foliar cover is >20% (field)	3.0%	1.06%	5%	3	No	Continue monitoring
	6	Mesquite (*Prosopis* sp.) foliar cover is >20% (subcanopy)	1.6%	0.79%	5%	2	No	Continue monitoring
Exotic plant dispersal	7	Extent (plot frequency) of invasive exotic plants in any layer is >20%	100%	n/a	n/a	n/a	YES	Meet and consider
Exotic plant invasion	8	Proportion of foliar plant cover (%) contributed from exotic plants in field layer (etc.) is >10% (field)	3.78%	0.94%	5%	2	No	Continue monitoring
	8	Proportion of foliar plant cover (%) contributed from exotic plants in field layer (etc.) is >10% (subcanopy)	5.12%	1.96%	5%	9	No	Continue monitoring
	8	Proportion of foliar plant cover (%) contributed from exotic plants in field layer (etc.) is >10% (canopy)	0%	0%	n/a	n/a	No	Continue monitoring

*If current status measurements fall within the levels indicated, then additional condition assessments are needed.
MDC = minimum detectable change (%)
n = number of plots to meet power assumptions under our criteria (see text).

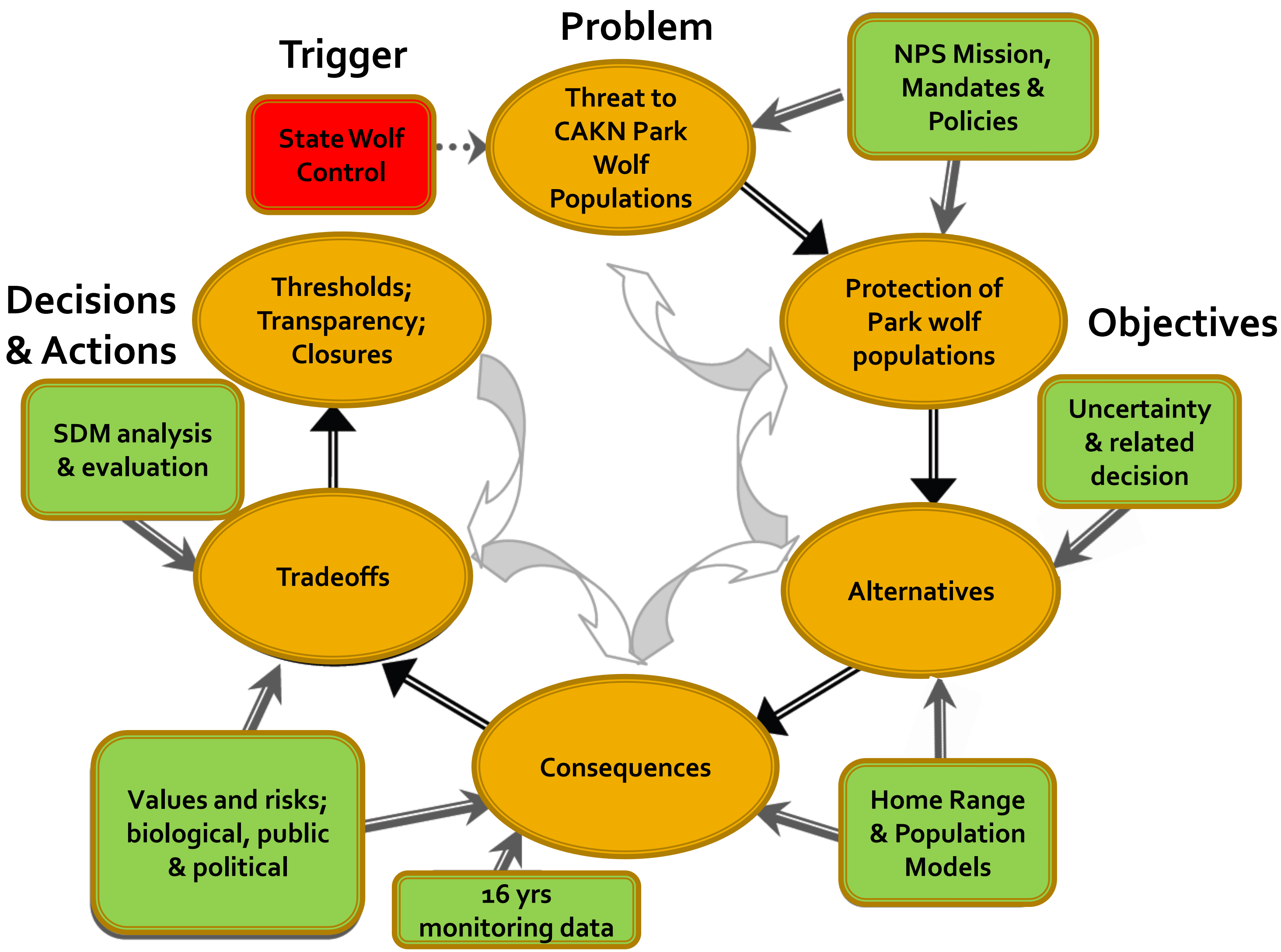

Assessment Point
Total Suite of Values
Weigh Values Against Risk of Irreversible Change
Feasibility of Managment Influence
Prior to Irreversible Degradation
Allowing for Sufficient Lead time for Possible Managment Actions
CONSIDER OPTIONS
STOP
TAKE A LOOK
Management
Monitoring Data
Proximity to Undesirable Condition or Ecological Thresholds
Status of all Indicators

Wolf Management: CAKN Parks YUCH, WRST, DENA

- **Issue: State predator control program around Preserve boundary could extirpate entire Preserve wolf population**
  - Conflicts with NPS mission and mandates

- **Preserve has 16 yrs of population data on wolf packs**
- **Used Structured Decision Making (SDM) to determine optimal management decision given Preserve objectives**
  - **Provided transparent way to incorporate data and policy in decision threshold**
  - **Superintendent took closure action**

Structured Decision Making



Adapted USFWS

Monitoring Ecological Response to Climate Change in the Desert Landscape Conservation Cooperative

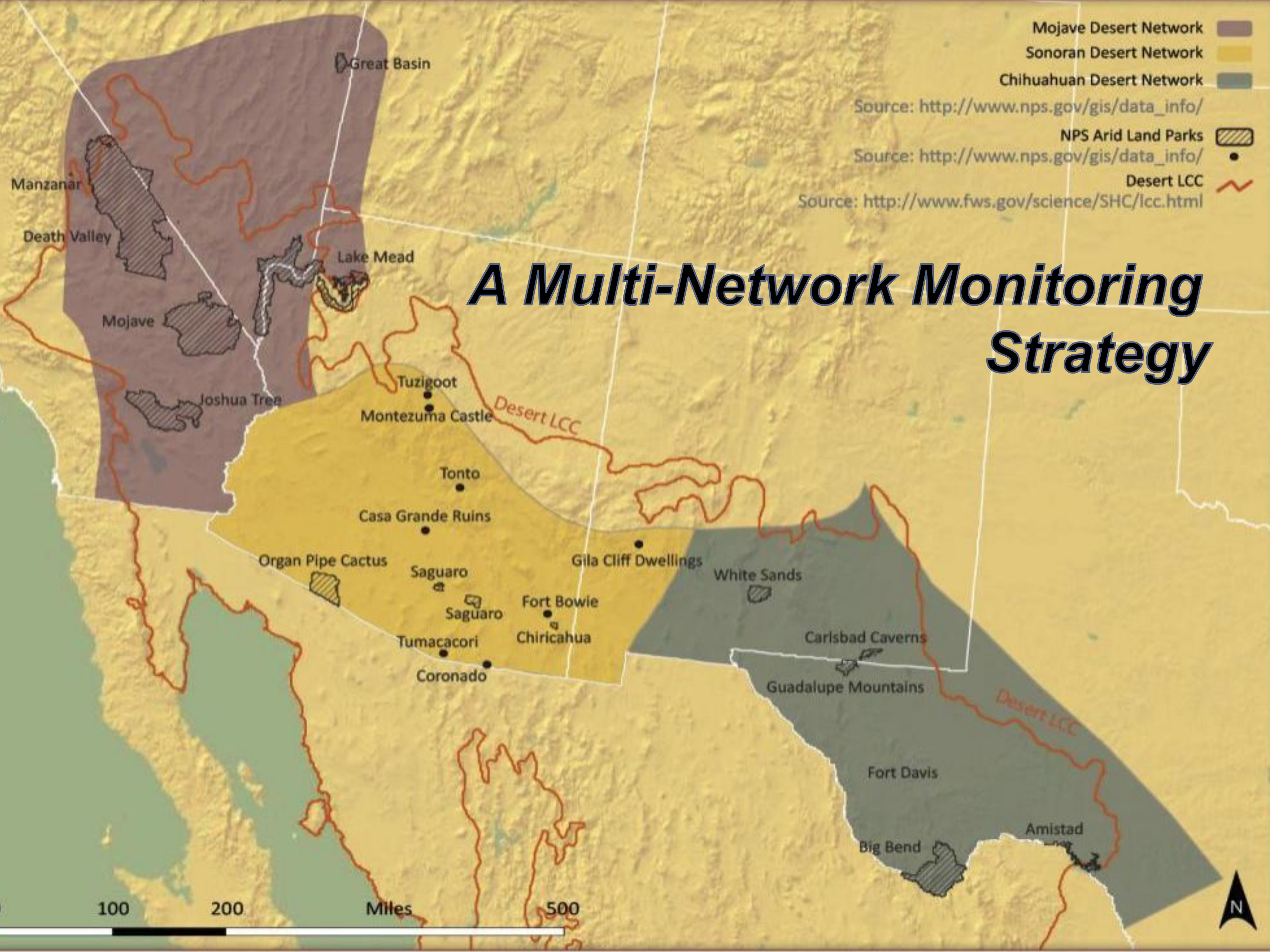
April 6-7, 2010
Tucson, AZ

Monitoring Ecological Response to Climate Change

- Modest increase to I&M base – approx 12%
- Focus on most vulnerable resources
  - Arid Lands
  - Coastal
  - High Elevation
  - High Latitude

Enhance existing monitoring, information integration, data analysis, reporting and collaboration

A Multi-Network Monitoring Strategy



Build on Existing Monitoring

Mojave Desert Network
Climate Change Resource Brief

Pacific West Regi
Inventory & Moni
National Park Ser
U.S. Department o

Climate Change and the Mojave Desert
Desert ecosystems are sensitive indicators of climate change because small changes in temperature and precipitation (quantity, timing, frequency, and distribution) can have significant effects on physical resources and biological communities. Mojave Desert Network is currently developing protocols to monitor several Vital Signs that may reflect current and future impacts of climate change.

The namesake of Josh
Joshua tree (*Yucca br*
significant changes in
change.

Groundwater and Springs Monitoring
Within Mojave Desert Network parks, significant biodiversity may be found at springs, which range from small, ephemeral mountain-front springs to large, perennial springs fed by carbonate-rock aquifers. Because the quantity of water (discharge) flowing from small mountain-front springs is affected by precipitation patterns, climate change may affect these springs and the associated plant and animal communities that depend on each spring's discharge patterns. At a selected subset of these springs, this network will monitor discharge, water quality, and the associated macroinvertebrate, riparian plant, and bird communities.

Streams and Lakes Monitoring
Diverse landscapes within the Mojave Desert Network also encompass high mountain streams and alpine lakes. Continuous measurements of lake level and stream discharge at Great Basin National Park may reflect changes in the amount and timing of precipitation and snow-melt. We will also monitor stream and lake water temperatures, lake ice-out and ice-over dates, and water quality, all of which may be affected by changes in air temperature and/or snow melt processes and all of which are important ecological variables.

Climate change may a
springs and seeps, wh
natural water sources

Vegetation Communities and Invasive Plants
The Mojave and Great Basin deserts support a wide range of upland vegetation communities from desert scrub to subalpine forest. Changing patterns in precipitation and temperature have the potential to shift the latitudinal and elevational distribution of some communities and threaten the persistence of others (e.g. Joshua tree, bristlecone pine). Changes in climate, combined with anthropogenic effects such as nitrogen deposition, may also result in the displacement of native plants by exotics, range expansions of new plant species into network parks, and the establishment of new ecological processes such as the grass-fire cycle, which is detrimental to many native plant species. The network will monitor structure and composition of selected vegetation communities and biological soil crusts to identify long-term changes which may be caused by climate change. In addition, network parks will implement early detection procedures to identify range expansions and contractions of invasive exotic plants.

An increase in invasive grasses and annuals could change the desert landscape by establishing a fire cycle to which native plants are not adapted.

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Sonoran Desert Network
Information Brief

National Park Service
U.S. Department of the Interior

Intermountain Region
Inventory & Monitoring Program

2010

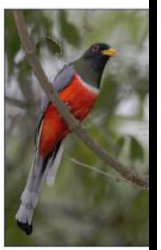
Climate Change in the Sonoran Desert Network
Current Findings and How Future Monitoring

How might climate change affect a place like the Sonoran Desert, whose bi-modal precipitatio
area's amazing species and lifeform diversity? The Sonoran Desert and its "sky islands" are un
the southernmost habitat for temperate species and the northernmost habitat for tropical spec
unique assemblage of flora and fauna that has responded to previous climatic changes. Over th
have established and flourished, and others have been extirpated.

The Sonoran Desert Network (SODN) is one of 32 National Park Service inventory and monit
vital signs monitoring to assess the condition of park ecosystems and develop a stronger scient
ment of natural resources across the National Park System. The SODN is monitoring several vit
of climate change. This brief offers a summary of the network's local-scale findings to date, as
monitoring will detect future change.

Current Findings

Bird Species Found North of its Historical Range
In 2008 and 2009, Sonoran Desert Network landbird monitoring detected elegant trogons (*Trogons elegans*) nesting at both units of Montezuma Castle National Monument. The park is located in north-central Arizona, several hundred miles north of the previously documented distribution for this beautiful and distinctive tropical species, which was previously thought to extend only to the borderlands of south-eastern Arizona. It is believed that milder winter and spring seasons linked to climate change may have permitted an extension of this species north, to exploit the riparian environments of the Verde Valley just south of Flagstaff, Arizona.



Elegant trogons have recently
National Monument, far nort

Vegetation Change at Saguaro National Park Indicates Shift Toward Warm-season Plants
To support the development of a vegetation monitoring protocol, staff at the Sonoran Desert Network and Saguaro National Park located and remeasured permanent vegetation plots established in 1976, in the Cactus Forest area of Saguaro National Park. Designed to document potential grazing effects on native vegetation, this extensive study instead illustrated a major increase in the abundance of shallow-rooted subshrubs, grasses, and other herbs, at the expense of deeper-rooted trees and shrubs. Deeper-rooted species are primarily supported by cool-season precipitation, whereas shallow-rooted species tend to take advantage of the brief, intense pulses of moisture following summer thunderstorms. These shifting vegetation patterns mirror changes in seasonal precipitation measured over the last 30 years, illustrating the close linkages between ecosystems and the bi-modal precipitation regime that defines the Sonoran Desert, and tracking predicted regional effects of global climate change.

A recent study at Saguaro NP
the abundance of shallow-roo
deeper-rooted trees and shru
serve as nurse trees for sagua

Chihuahuan Desert Network
Information Brief

National Park Service
U.S. Department of Interior

Intermountain Region
Inventory & Monitoring Program

Climate Change and the Chihuahuan Desert
The Chihuahuan Desert Network (CHDN) is one of 32 National Park Service inventory and monitoring networks implementing Vital Signs monitoring to assess the condition of park ecosystems and develop a strong scientific basis for stewardship and management of natural resources across the National Park System. The CHDN is currently developing protocols to monitor several Vital Signs that may reflect current and future impacts of climate change. This brief offers a summary of how CHDN monitoring will detect future change.

Seeps and Springs
Water and water-dependent ecosystems are scarce resources in the arid southwest, and are generally regarded as biodiversity hotspots. Seeps and springs are critical surface water sources and are among the most restricted habitats for plant and animal species. Precipitation is critical to the existence of seeps and springs. The size, frequency, and duration of precipitation events are key factors influencing spring-water availability. Climate change is expected to alter surface water quantity, as well as seasonal patterns of flooding and drought, and springs will be a direct indicator of these changes. The CHDN will monitor discharge, water quality, macroinvertebrates, and vegetation at a subset of springs in the network.

Smith Springs at Guadalupe Mountains NP is one of many springs in the CHDN that serve as an important source of water for plants and animals. D. Bieri photo.

Groundwater
In the Chihuahuan Desert, groundwater is the source of most surface water bodies. Availability of groundwater also has critical consequences for plants, animals, and nutrient, water, and energy flows. In many parts of the American Southwest, long-term drought and human development have already led to significant declines in groundwater levels at local and regional scales. Impacts to groundwater resources associated with reduced infiltration and storage, often related to soil loss and changes in surface characteristics, can be directly addressed by management actions aimed at soil conservation and recharge enhancement. The possibility of a reduction in precipitation recharge related to climate change, however, would be far more problematic and have the potential for broad-scale impacts to surface-water systems. The CHDN will monitor groundwater quantity in wells throughout the network.

Lower: Climate change may have direct and indirect effects on streamflow and water quality in the Rio Grande, which also has the exotic plant *Arundo*, growing along its banks. R. Skiles photo.

Rivers
Chihuahuan Desert Network parks contain 247 miles of the Rio Grande, as well as the confluence of the Devils, the Pecos, and the Rio Grande in Amistad National Recreation Area. The condition of these rivers within CHDN parks is greatly influenced by drivers and stressors occurring across the landscape in areas located well beyond park boundaries. Climate change may have direct and indirect effects on streamflow and water quality. As temperature and precipitation patterns affect the abundance, type, and distribution of vegetation cover in watersheds, changes in flood magnitude and duration, sediment loads, and water chemistry will likely occur. CHDN monitoring of water quality, channel morphology, macroinvertebrates, and stream discharge will allow park managers to address proximate issues occurring within park boundaries and will also provide an index of overall watershed condition.

http://science.nature.nps.gov/im/climate/index.cfm

Common Vital Signs

MOJN (14)	CHDN (21)	SODN (18)
	Aquatic Invertebrates	Aquatic Invertebrates
Biological Soil Crusts	Biological Soil Crusts	Biological Soil Crusts
Groundwater Dynamics & Chemistry	Groundwater Quantity	Groundwater Dynamics
Riparian Bird Communities	Bird Communities	Bird Community Dynamics
Invasive/Exotic Plants	Invasive/Non-native Plants	Invasive/Non-native Plants
Landscape Dynamics	Landscape Dynamics	
	River Channel Characteristics	Channel Morphology
Soil Disturbance	Bare Ground	Soil Compaction
Soil Erosion & Deposition	Soil Erosion (Wind and Water)	Soil Cover & Aggregate Stability
Soil Hydrologic Function	Soil Hydrologic Function	
Surface Water Chemistry	Surface Water Quality	Water Quality
Surface Water Dynamics	Surface Water Dynamics	Surface Water Dynamics
Vegetation Change	Vegetation Composition	Vegetation Composition and Structure

Workshop Outcome: Priorities

- **Spring Distribution and Water Availability**

Objective: Determine sensitivity of springs to climate change and monitor patterns of water availability (timing, amount) across the landscape

- **Leading Indicators of Climate Change**

Objective: Enhance existing protocols to collect additional information to identify species most sensitive to climate change

- **Climate Protocol Development**

Objective: Consistent protocol for reporting data based on park needs and at the LCC scale

- **Phenology and Snowpack**

Objective: Evaluate MODIS and similar technologies for broad-scale monitoring of phenology, snowpack, and productivity

- **Communication**

Objective: Enhance Learning Center of the American Southwest (LCAS) to report climate change information across the LCC